TECHNICAL ASSESSMENT DOCUMENT

FURTHER STUDY MEASURE 8
PRESSURE RELIEF DEVICES

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Table of Contents

I. EXECUTIVE SUMMARY

As part of the San Francisco Bay Area 2001 Ozone Attainment Plan for the 1-Hour National Ozone Standard, the Bay Area Air Quality Management District (BAAQMD or The District) committed to study several activities to determine if additional emission reductions could be achieved and whether implementation of control measures is feasible. The District has the lead for Further Study Measure 8 for Pressure Relief Devices (PRDs), Blowdown Systems, and Flares. This technical assessment document (TAD) presents the findings for PRDs. Separate TADs are being prepared for the other portions of this study. Participation in this study included the California Air Resources Board (ARB), the Environmental Protection Agency (EPA), affected industry, and the public.

A. Scope of Technical Assessment

Pressure relief devices or pressure relief valves (PRVs) are safety devices that are installed on process units to release overpressures that could threaten the integrity of process vessels. PRDs are typically vented in one of three ways; directly to atmosphere, to an uncontrolled blowdown system, or to a flare system. Potential emission reductions through enhanced enforcement, additional control requirements, and/or expansion of the scope of the current regulations were also evaluated. Staff evaluated current industry practices and considered the feasibility of requirements to implement prevention measures to minimize or eliminate venting to the atmosphere. A Rule Audit was conducted over a six month period starting October 2001 to determine the District's ability to independently verify PRD ventings.

B. Findings

Based on this assessment, staff finds:

- Current instrumentation is not adequate to determining if a PRD has vented.
- Telltale indicators on PRDs are not the industry practice.
- Industry practice varies. PRDs are vented to the atmosphere, to an uncontrolled blowdown system, or to a flare system. One refinery may have several PRDs vented directly to atmosphere on a process unit, while another refinery may have none on a similar process unit.
- Most pressure data are recorded as one-minute averages. Ventings less than one-minute may not be recorded.
- From the 2002 Audit, previously undisclosed and detecteded PRD overpressures were identified.
- Repeated ventings at the same PRD are not being addressed by facilities because of deficiencies in the District's current Regulation 8, Rule 28. The trigger for the requirements is based on turnaround (scheduled maintenance) dates and time lines initiated by report submittals rather than actual date of the ventings.

- Current reporting requirements in Regulation 8-28-401 are not adequate to quantify and verify emissions.

1. Emission Inventory

The District inventory for PRDs currently estimates organic emissions at an average of 0.9 tons per day. These emissions are episodic in nature, are difficult to detect and verify, and can vary significantly from day to day. Since 1993, the largest known PRD episode resulted in hydrocarbon emissions of approximately 150 tons.

2. Potential Control and Monitoring Strategies

Based on this assessment, monitoring provisions are necessary and consist of two types of strategies. They are telltale indicators and pressure monitors.

Based on this assessment, there are two types of potential control strategies to control emissions from PRDs; control equipment, and pollution prevention

3. Cost and Cost-Effectiveness

The cost to monitor PRD ventings can vary greatly. The cost to control atmospheric PRDs is difficult to quantify. Each situation is different and may require unique piping configurations to a recovery or disposal system.

II. Recommendations

Based on this assessment, staff recommends:

A. Control Measure Development

It is recommended that Regulation 8, Rule 28 be amended.

- Remove "turnaround" reference when determining applicability.
- Redefine/clarify timelines that are basis for the definition of repeat ventings.
- Require monitoring and or telltale indicators so that ventings can be verified and the emissions quantified.
- Include a leak or emission standard, and an inspection program for all PRDs.
- Implement recommendations from 1996 Rule Effectiveness Study and 2002 Rule Audit.

B. Enforcement Practices

It is recommended that a Compliance Advisory be issued to petroleum refineries and chemical plants to clarify the information required under Regulation 8-28-401. Currently, the reports are not adequate to determine and verify the cause, emission consequences and prevention methods.

III. Introduction

A. Background

Pressure relief devices or pressure relief valves are safety devices that are installed on process units to release overpressures that could threaten the integrity of process vessels. The emissions from PRDs are handled in a variety of ways. Some PRDs are vented to the atmosphere or through manifolds to uncontrolled blowdown systems. Other PRDs are vented to blowdown systems with a gas recovery system and a flare. Figure 1 shows a group of PRDs that vent directly to atmosphere.

Figure 1

District regulations require that PRDs on new refinery sources be vented to a gas recovery system or to flares. District regulations also require control for existing PRDs that release to the atmosphere more than once within a five-year period.

B. Existing Regulations

1. District Requirements

Regulation 8, Rule 28, Episodic Releases From Pressure Relief Devices At Petroleum Refineries and Chemical Plants was adopted July 16, 1980 and amended March 17, 1982, July 20, 1983, and December 17, 1997. The purpose of the Rule is to prevent the episodic emissions of organic compounds from PRDs through prevention measures, and to control PRDs that repeatedly vent to atmosphere.

Regulation 8, Rule 18 states that a person shall not use any pressure relief device that leaks total organic compounds in excess of 500 ppm unless the leak has been discovered by the operator, minimized within 24 hours and repaired within 15 days; or if the leak has been discovered by the APCO, repaired within 7 days. The provisions of this Rule shall not apply to pressure relief devices vented to a vapor recovery or disposal system which reduces the emissions of organic compounds from the equipment by 95% or greater.

The requirements for PRDs at new or modified sources at petroleum refineries are the applicable requirements of Regulation 2, Rule 2, including Best Available Control Technology (BACT), and the Prevention Measures Procedures specified in Section 8-28-405. BACT is defined to include a rupture disk and venting to a control device with a minimum efficiency of 98%.

2. Federal Requirements

Federal New Source Performance Standards (NSPS) requires that PRDs be operated without leaks above 500 ppm as carbon. For PRDs that vent to a recovery and destruction system, the system is required to be designed and operated to reduce the volatile organic compound (VOC) emissions with an control efficiency of 95% or greater.

3. Other Air District Rules

South Coast Air Quality Control District adopts by reference NSPS requirements. Regulation 1173 sets limits on fugitive emissions from PRDs. It is currently undergoing amendment that would establish requirements for PRDs that vent directly to atmosphere. Some of the new requirements include criteria for controls and/or mitigation fees, monitoring and release notification.

Ventura County Air Pollution Control District Rule 74-7 places regulatory limits on PRDs. For a major gas leak or a major liquid leak from a PRD, the owner or operator shall replace or retrofit the leaking PRD with a rupture disc and vent the PRD to a recovery/disposal system with 90% control efficiency.

San Joaquin Valley Air Pollution Control District Rule 4451 limits leaks from PRDs to less than 10,000 ppm as carbon. Emissions from PRDs vented to a control device must be controlled by at least 95%.

Santa Barbara County Air Pollution Control District Rule 331 sets standards for PRD leaks at 10,000 ppm as carbon.

C. Bay Area Air Quality Management District's Recent Works

1. 1996 Rule Effectiveness Study and PRD Audit

A Rule Effectiveness Study was conducted that identified PRDs at the five petroleum refineries, verified compliance, and reviewed emissions records and compliance history.

2. 2002 PRD Audit

A Rule Audit was conducted to determine the District's ability to independently verify PRD ventings.

IV. Supporting Data and Discussion

A. Inventory

The 1996 study identified 715 PRDs that vent directly to the atmosphere. This total includes thermal relief valves, valves that service liquid streams. The 2002 audit identified 310 PRDs that are subject to Regulation 8-28 requirements. The following table lists the number of PRDs by refinery.

Inventory of PRDs that Vent Directly to Atmosphere

Refinery	**Total***	**PRDs Subject To 8-28****
Chevron	165	41
Conoco/Phillips	15	8
Martinez Refining Company (Shell)	198	88
Tesoro	280	107
Valero	57	66
Total	**715**	**310**

*from 1996 data
**from 2002 data

Emissions from thermal relief valves and unreported ventings may increase this estimate.

B. Investigation of PRD Episodes

Since 1998, an average of 12 PRD episodes per year were reported to the District. In 1993, a single event resulted in VOC emissions of approximately 150 tons.

Staff investigated selected episodes that were reported to the District. The objective of the investigations was to identify the cause, determine prevention methods and quantify emissions. Since 1999, 35 PRD releases were reported to the District.

Summary Of Reported Episodes

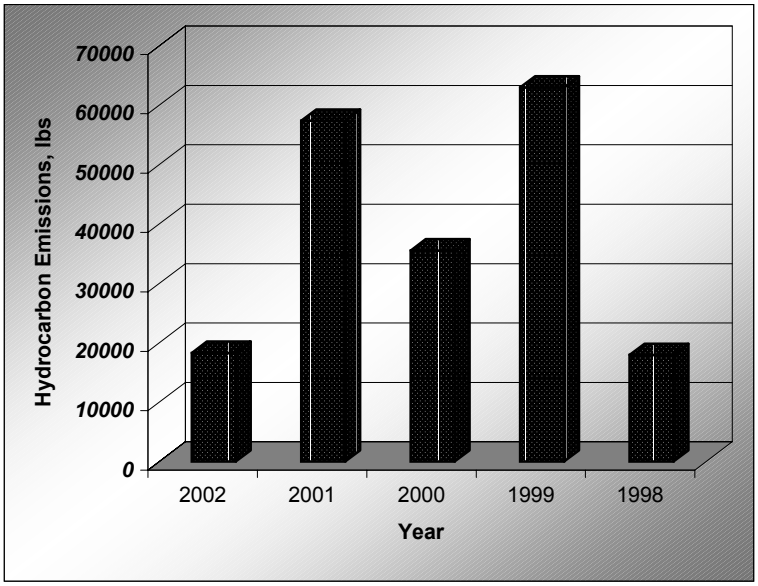
EPISODE DATE	SOURCE NAME	Cause/Comments	H_2S*, lbs	Hydrocarbon*, lbs
08/03/1998	CokerGas Plant	Electrical fault resulting in a voltage drop through refinery	202	5240
08/05/1998	Coker/Gas Plant	Solenoid failure on wet gas compressors and inadequate flare system release	490	12,710
08/27/1998	Crude Unit Desalter Water Treatment Unit	Water only, event cancelled		< 10
12/01/1998	Reformer Unit	Vessel overfilled due to level indicator failure		(1 barrel of gas)
01/26/1999	HDS Prefractionator Feed Surge Drum	High liquid level in vessel and improper personnel responding to alarm		2765
03/04/1999	Catalytic Gasoline Hydrotreater	Upset downstream of debutanizer column due to flooding in column	23	3,600
03/06/1999	Splitter Tower Crude Light Ends	Inadequate pressure control program at tower reboiler during HCU startup		9,200
03/10/1999	Coker/Gas Plant	Inverter & 3 auto-transformer swithes failed causing intermittant power and wet gas compressor trips	14	32,000
03/19/1999	Dimersol Plant	Depropanizer column overhead pressure control in manual		5,000
04/16/1999	Wax Deoiler	Failure to depressure propane system and relief system recovery compressor		45
07/04/1999	Catalytic Gas Plant	Pentanes entered the gasoline column during start up of the Depentanizer		5,100
09/02/1999	HDS Prefractionator Feed Surge Drum	High liquid level in surge drum		1,490
09/26/1999	Alkylation Gas Turbine	Compressor check valve failure and operations blocked compressor discharge		1,079
10/13/1999	Catalytic Gas Plant	Backwashing the vapor condensers without an equivalent amount of cooling water		2,700
01/01/2000	Vacuum Flasher Column Crude Unit	Air leaks at discharge of 1st stage jets resulting in loss of very light flashed distillate level in column	4,500	23,000
06/19/2000	Wax Deoiler	Operator closed valve resulting in overpressure of E322B chiller		6.47
09/08/2000	DH3 Gas Oil Straightrun Hydrotreater	Vent header compressor shutdown due to high liquid level	140	12,000
10/12/2000	Catalytic Gas Plant	Column feed composition changes after upset		530

EPISODE DATE	SOURCE NAME	Cause/Comments	H_2S*, lbs	Hydrocarbon*, lbs
03/05/2001	Natural Gas Heater	Control valve put on manual causing high backpressure		3,680
06/13/2001	Coker-Main Fractionator Accumulator, Wet compressor	Request for withdraw, Unable to verify		NA
07/18/2001	DH3 Gas Oil Straight Run Hydrotreater	Various operational and maintenance problems, 15# header pressured up to capacity & not vented to flare	80	31,000
07/27/2001	DH3 Gas Oil Straight Run Hydrotreater	Water in feed during startup.	4.3	1,500
08/09/2001	Hydrocracker Unit 1st Stage Fractionator Column	Malfunctioning speed controller on recycle compressor	17	670
08/09/2001	Straight Run Hydrotreater Primary Column	Column unable to vent to 15# header due to upset at HCU had pressured up header	150	12,000
08/22/2001	Cat Cracker Unit Debutanizer Column	PSV lifted prior to setpoint	1	3,200
08/28/2001	Lube Solvent Extraction Plant	Pressure control valve malfunction		800
10/12/2001	Fluid Cat Cracker Unit, Main Fractionator Column	Valve to flare failure	6.3	7,300
10/16/2001	Fluid Cat Cracker Unit, DeButanizer Column	CV-341 improperly ranged		950
11/01/01	Vapor Recovery Storage Tank Compressor	Faulty pressure transmitter, Natural gas release of 330 lb		Not Applicable
11/29/2001	Crude Unit (Asphalt Plant)	Fuel Gas Backpressure		
03/28/02	Flexicoker/Coker Gas Plant's exchanger	Plugged line at heat exchanger, not subject to 8-28 for non-precursor organic emissions		190
9/12/02	Crude Unit 50, 1st Stage Desalter	Malfunction of control valve to at one of three Flash Tower Bottoms		5,300
9/25/02	Marine Loading Berth, vapor recovery system	Compression loading because vessel could not keep pressure		300
10/12/02	Crude Unit 50, 1st Stage Desalter	Check valve malfunction: valve was stuck in open position		5,250
10/19/02	Crude Unit 50, 1st Stage Desalter	Unable to control operational change		7,250

* Calculated by the facility

The following graph shows a representation of the hydrocarbon emissions from the reported episodes.

Hydrocarbon Emissions from Reported Episodes



The following tables show examples of hydrocarbon emissions from a hypothetical release. Three different phases at two different pressures values were inputed into the formula given in the Crosby Engineering Handbook, Valve Sizing and Selection. The highest mass emissions occur during a two-phase release (vapor with liquid entrainment) under high pressure and through a large orifice. The material was assumed to be butane at 340 °F.

Estimated Hydrocarbon Emissions for a 100 % Vapor Release for 10 Minutes

Orifice Size, inches	Pressure, psi	Flow, lb/min	Emissions assuming 10 minute release, tons
4	200	2,200	10
6	200	5,500	25
4	1000	18,000	90
6	1000	45,000	225

Estimated Hydrocarbon Emissions for a
100 % Liquid Release for 10 Minutes

Orifice Size, inches	Pressure, psi	Flow, lb/min	Emissions assuming 10 minute release, tons
4	200	14,900	75
6	200	37,400	190
4	1000	33,300	170
6	1000	83,600	420

Estimated Hydrocarbon Emissions for a
Two-Phase Release for 10 Minutes
(20% liquid, 80% Vapor)

Orifice Size, inches	Pressure, psi	Flow, lb/min	Emissions assuming 10 minute release, tons
4	200	4,700	25
6	200	11,900	60
4	1000	21,000	105
6	1000	52,700	265

C. Bay Area Air Quality Management Studies

The 1996 study identified a large number of leaking PRVs. Many PRD ventings were undetected and unreported. The leak detection methods at each refinery were not consistent or adequate.

The main recommendations from the 1996 study were:

- Uncontrolled PRDs should vent to a recovery/control system.
- PRDs should be continuously monitored for leaks and fitted with block valves to allow repair without a complete unit shutdown.
- Uncontrolled PRDs should be fitted with monitors to determined duration of ventings.
- PRDs should not be manifolded together because it prevents isolation of individual leaks.
- District should develop a policy requiring quarterly checks of all uncontrolled PRDs.
- Thermal relief valves should be included in the leak monitoring program.
- Clarify Regulation 8, Rule 28 to ensure propane, butane, and LPG tanks are subject to the rule.

In 2002, an audit of PRDs that vent directly to atmosphere was completed at each refinery. Staff requested all records available for a twelve-month period and conducted numerous site visits over the six-month audit period.

The main findings from the 2002 audit were:

- Independent verification of PRD ventings is not possible.
- Telltale indicators are not commonly used.
- Pressure recorders are not reliable.
- Short-term exceedences of PRD set pressures may not be recorded.
- Previously undisclosed/unreported PRD ventings were discovered.
- The primary method of detecting PRD ventings is by sound when no instrumentation is available.
- Repeated ventings at the same PRD are not being addressed by facilities because of the deficiencies in the District's current Regulation 8, Rule 28.
- Current reporting requirements under Regulation 8-28-401 are not adequate to quantify and verify emissions.

V. References

Final Report for Rule Effectiveness Study on Pressure Relief Valves At Petroleum Refineries and Chemical Plants (Regulation 8, Rule 28), Dick Wocasek, Bay Area Air Quality Management District, November 1995, revised April 1996

Pressure Relief Device Audit Report (Bay Area Refineries), Jeff Gove and Tim O'Conner, Bay Area Air Quality Management District, May 2002

Crosby Engineering Handbook, Valve Sizing and Selection